APPENDIX A

STATEMENT OF WORK

"ADVANCED HEAVY HYBRID PROPULSION SYSTEMS FOR INCREASED FUEL EFFICIENCY AND DECREASED EMISSIONS"

April 30, 2002

1.0 BACKGROUND

A productive, innovative U.S. trucking industry is essential to U.S. economic prosperity. Current estimates suggest that 80% of the total quantity of goods included in the gross domestic product is transported by various classes of trucks[1]. Therefore, satisfying truck transportation energy requirements for goods transport and for services within the economy is critical to the U.S. economy. According to 1997 figures, the approximately 5.5 million Class 3 through Class 8 commercial trucks use approximately 22.9 billions gallons of fuel annually[1]. This is one of the fastest growing fuel/energy use transportation sectors, and indeed all Class 1 through Class 8 truck energy use accounts for all of the increase in highway transportation energy use in the last 30 years. This has led to the increasing reliance in the U.S. on imported foreign oil and strongly contributed to a major national security issue for the U.S. A major goal of this program is to significantly reduce U.S. dependence on imported foreign oil.

The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (OEERE), FreedomCAR and Vehicle Technologies (FCVT) Program Office, represented by the National Renewable Energy Laboratory (NREL), is consequently seeking cost-shared research and development for advanced, next-generation heavy hybrid (truck and bus) propulsion systems and hybrid vehicle systems. Vehicle weight classes between Class 3 and Class 8 are included. It is anticipated that advanced heavy hybrid vehicles will be commercialized in multiple heavy-duty vehicle classes in the latter part of this decade, providing significant improvements in vehicle fuel efficiency, while simultaneously reducing vehicle emissions. Examples of technologies appropriate to this effort are described in the Scope of Work section below.

FCVT has an ongoing heavy hybrid program that was started in FY 2000. This successful program is drawing to a conclusion in FY 2003 and FCVT wishes to further advance next-generation heavy hybrid technology with the goal of achieving higher vehicle efficiency and lower emissions. As an adjunct to the heavy hybrid program, FCVT in FY 2002 is initiating a program to develop Essential Power Systems (EPS) for more efficient, practical, and cost effective management of electrical, mechanical, and thermal power on trucks. The EPS is expected to provide a possible pathway for future truck electrification. FCVT envisions a linkage of the EPS program with the advanced heavy hybrid program. FCVT also has ongoing projects in diesel engine research, exhaust after-treatment, heavy vehicle systems research (e.g., aerodynamic drag, friction and wear, thermal management), and materials.

[1] "Technology Roadmap for the 21st Century Truck Program – A Government-Industry Research Partnership", Report #21CT-001, December 2000.

2.0 OBJECTIVE

The goal of the cooperative government/industry advanced, next- generation heavy hybrid program is to complete technology development by 2008, and with industry leadership provide a technology pathway to commercialization cost structures for advanced heavy hybrid vehicles by 2010. It is recognized that the heavy-duty vehicle industry, in the transition to hybrid propulsion, would like to utilize some light-duty vehicle component technology, taking advantage of high production volumes and low costs to reduce the cost of heavy hybrid vehicles.

An initial technical benchmark objective for the hybrid powertrain technology is to develop and demonstrate cost-effective, advanced, next-generation heavy hybrid components and systems, which at the vehicle-level could provide, contribute to, or enable up to a 100 percent increase in powertrain fuel efficiency relative to today's conventional powertrain technology, while meeting year 2007 Environmental Protection Agency (EPA) emissions standards shown in Table 1. Consult http://www.dieselnet.com/standards/us/hd.html#2007 for a more thorough discussion of the 2007 EPA emissions and fuel standards. It is recognized that the increase in powertrain fuel efficiency will depend strongly on the specific component and system technology being researched, and the vehicle classes and drive cycles. The NREL/DOE are interested in the various benefits of a given component and system technology on various vehicle classes and driving conditions and cycles.

Table 1 – Environmental Protection Agency 2007 Engine Emissions & Fuel Standards

	NO_x Requirement	Particulate Matter Requirement	Non-Methane Hydrocarbon Requirement	Diesel Fuel Sulfur Requirement
Requirement Level	0.2 g/bhp-h	0.01 g/bhp-h	0.14 g/bhp-h	15 ppm
Year of Effect	2007-2010 Phased In	2007	2007-2010 Phased In	June 2006

One of the issues to be addressed in the commercialization pathway for hybrid propulsion is the extended reliability and durability requirements of heavy-duty vehicles compared to light-duty vehicles. Maintaining or increasing vehicle and component reliability and durability through this technology development effort are major NREL/DOE objectives. Heavy vehicles can typically have reliability and durability requirements up to 10 years of operation and 500,000-1,000,000 miles. The advanced, next-generation technologies sought in this technology development effort should seek to satisfy these objectives while providing a clear advance in technology to reduce energy and fuel consumption.

The program objectives will be accomplished through a dual phase program. Phase I will be a technology development program intended to design, develop, characterize, and show feasibility of energy and fuel saving heavy vehicle hybrid propulsion technologies. The potential Phase II (not a work effort of this statement of work) will be a technology demonstration program intended to demonstrate and validate Phase I technologies in an actual Class 3 to Class 8 heavy vehicle demonstration.

3.0 SCOPE OF WORK

This subcontract shall accomplish the above research objectives in a period of three (3) years, with quarterly reviews to assess progress and interim results. The subcontract will first develop an implementation plan for approval by NREL/DOE. This activity will be followed by a technology

development and feasibility/benefit evaluation which will involve scientific studies and evaluations, refinements of concept definitions, design configuration evaluations, design tradeoff studies, reliability evaluations, system integration studies, control strategy studies as necessary, and market and commercialization evaluations of the concept design. The results of these studies and evaluations will be presented at the quarterly reviews and in monthly reports to NREL/DOE. The goal of these efforts will be to understand and demonstrate design feasibility of the proposed technology/concept and provide a convincing case for commercialization potential. This effort will culminate in a Final Phase I Report and briefing to NREL/DOE on the proposed technology/concept. Subcontractor will investigate the complementary development opportunities that might exist between EPS technologies and powertrain related technologies for next-generation heavy hybrid vehicles and identify the synergies and program leverages that could exist.

Programmatic goals include the desire for a portfolio of future research projects balanced with respect to sector (i.e., primary, semi-fabricated, and finished product), long-term vs. short-term market penetration horizons, and short duration vs. long duration projects.

The advanced heavy hybrid program encompasses a variety of technologies, systems, and evaluation tools, such as:

- Advanced and novel engine prime power concepts
- Low cost and light weight power electronics
- Advanced energy conversion and energy storage technologies and systems
- Advanced transmission and powertrain components and systems
- Advanced computerized powertrain algorithms
- Advanced thermal and fluid management concepts
- Advanced materials for hybrid powertrains and vehicle systems
- Advanced computer modeling for powertrain, component, and vehicle systems design optimization and evaluation
- Engine and aftertreatment optimization

A cross-cutting research and development effort is required to develop and integrate promising technologies in these areas for heavy hybrid propulsion systems. Work effort should complement existing FCVT and other government agency programs. Information on heavy vehicle technology programs may be found at http://www.trucks.doe.gov**.**

Advanced & Novel Engine Prime Power Concepts. Advanced and novel engine prime power concepts with fundamentally increased fuel efficiency and lower emissions are required to meet future advanced vehicle requirements. Novel concepts to optimize in-cylinder combustion and heat transfer characteristics to increase thermal efficiency, while maintaining or reducing in-cylinder emissions, could be beneficial to achieving program goals. Research and development appropriate to this topic include advanced and novel concepts in the areas of advanced hybrid diesel engine concepts, advanced diesel engine concepts which support and facilitate hybridization, advanced fuel-injection systems, combustion- and emissions-control technologies, and other novel hybrid diesel engine concepts with the potential of increased fuel efficiency and reduced emissions consistent with the goals of this program.

Low-Cost and Light-Weight Power Electronics. Heavy hybrid vehicles will require inexpensive, light-weight, and simplified power electronics which can be easily integrated into heavy hybrid approaches and systems. In particular, small-volume power electronics with higher durability and reliability are needed to

control voltage, frequency, switching timing, and state-of-charge conditions and manage system power outputs from the prime mover, electric motors, and auxiliary power units. Research and development appropriate to this topic include advanced DC-DC converters, DC-AC inverters, advanced switching electronics, electronic modularization concepts, electromagnetic actuators, advanced capacitors and magnetic devices, and other advanced, novel power electronics to accomplish the missions associated with heavy vehicle hybrid propulsion.

Advanced Energy Conversion and Energy Storage Technologies and Systems. Advanced energy conversion technologies and systems are required for auxiliary power, energy storage, and energy/power management in advanced vehicles. Research and development appropriate to this topic include advanced and novel concepts in heavy-vehicle-integrated thermoelectric systems and other advanced energy conversion technologies integrated into systems that can supply 5-10 kW or more of auxiliary truck power. Research and development areas of interest also include advanced battery systems, ultra-capacitors, and flywheels to support heavy vehicle hybridization.

Advanced Transmission and Powertrain Components and Systems. The transmission systems and other powertrain components are critical to efficiently transferring energy to the vehicle wheels. Continuously Variable Transmissions (CVTs) hold promising benefits to heavy vehicles and their integration into heavy hybrid applications should be researched. Vehicle systems modeling should be conducted to simulate CVT functionality and potential synergies to foster the development of such technology. Advanced transmission systems for heavy hybrid propulsion must be integrated with the vehicle prime power to minimize energy losses and create high-efficiency energy transfer. Research and development appropriate to this topic include advanced, next-generation transmissions, CVT's, and powertrain components and systems that are effectively integrated with vehicle prime power to accomplish the program's fuel-economy enhancement and emission reduction goals.

Advanced computerized powertrain algorithms. On-board vehicle computer algorithms could be useful for controlling, managing, and maximizing efficient vehicle system energy use. This is intended to account for all energy use and management, including interrelated, coupled effects, throughout the vehicle. Research and development appropriate to this topic include computer technologies and algorithms that combine the effects of aerodynamic drag, rolling resistance, road grade, geographic positioning, weight, weather conditions (e.g., wind speed and direction), system thermal performance, and system electrical performance to assist in controlling vehicle motion and response as it relates to energy management.

Advanced Thermal and Fluid Management Systems. Auxiliary load systems, fuel and lubrication systems, and cooling systems are an integral part of any truck, and contribute to the overall design and energy use/management on any truck configuration. Research and development appropriate to this topic include advanced heat exchanger technologies, heat pipe/two-phase flow systems, advanced pumps and compressors, and other advanced thermal and fluid management concepts to improve electric powertrain cooling, enhance drivetrain performance, reduce energy usage, improve system energy management, and reduce component and system weight, volume, and aerodynamic drag in hybrid powertrains and hybrid vehicle systems.

Advanced materials for hybrid powertrains and vehicle systems. Material properties, performance and optimization will have a tremendous impact on all systems throughout a truck and on energy use / management within all such systems. Research and development appropriate to this topic include advanced high-temperature materials, carbon-fiber composites, porous materials, electronic materials, magnesium-based and titanium-based alloys, low-friction materials, and other novel advanced materials

that lead to enhanced energy use/management, reduced component and system weight and volume, aerodynamic drag reduction, and enhanced drive train performance in hybrid powertrains and vehicle propulsion systems.

Advanced computer modeling. NREL's vehicle systems work using ADVISOR[2] has shown that many vehicle energy saving techniques and methodologies can only be identified and implemented through a complete vehicle system modeling and design approach that encompasses all the interrelated, coupled energy use/management effects throughout the vehicle. Research and development appropriate to this topic include developing advanced computer modeling of powertrain, components and complete hybrid powertrain concepts, and advanced vehicle systems design optimization and evaluation, to leverage and extend the capabilities demonstrated in ADVISOR.

Engine and exhaust aftertreatment optimization. Aftertreatment systems should be integrated with advanced and novel engine concepts to produce engine systems with lower emissions, particularly NO_x, particulate matter, and non-methane hydrocarbons (NMHC). Specifically, better systems integration is required to allow aftertreatment sub-systems to operate more effectively. Research and development appropriate to this topic include programs to optimize EGR systems to reduce NO_x, improve NO_x absorber catalysts, develop advanced selective catalytic reduction (SCR), develop advanced diesel particulate filters (DPF), develop and integrate novel exhaust heat recovery systems, and create advanced sensor systems with higher reliability and durability, lower poison resistance, and faster response (< 15 ms). Other novel aftertreatment systems (e.g., plasma-based systems) are also of interest.

4.0 TASKS

A Phase I work effort, and a potential Phase II effort for successful and promising technologies, define the advanced heavy hybrid propulsion program. Each phase has associated tasks as described below.

Phase I – This phase will consist of technology feasibility research and development and exploration of alternative technology options. During the course of Phase I, the subcontractor shall demonstrate the technical feasibility and potential marketplace viability of truck/bus advanced, next-generation heavy hybrid propulsion components and systems. Subcontractor shall particularly address component and system technologies capable of producing or significantly contributing up to 100% increase, at the vehicle-level, in heavy vehicle fuel economy and increasing component and systems reliability and durability, while meeting year 2007 Environmental Protection Agency (EPA) emissions standards. The following tasks shall be accomplished:

> **Task 4.1. Program Implementation Plan Development.** The subcontractor shall provide a detailed written Implementation Plan and Work Breakdown Structure for the execution of Phase I. Proposed goals and technical and management approaches shall be identified for goal achievement. The plan shall identify the proposed tasks and responsibilities of all team members. The subcontractor will establish sufficient heavy-vehicle industry relationships and inputs that will influence and guide the Phase I Implementation Plan.

[2] T. Markel, A. Brooker, T. Hendricks, V. Johnson, K. Kelly, B. Kramer, M. O'Keefe, S. Sprik, K. Wipke, "ADVISOR: A System Analysis Tool for Advanced Vehicle Modeling," Journal of Powersources, 2002, http://www.ctts.nrel.gov/analysis/.

Task 4.2. Program Implementation Plan Briefing. The subcontractor shall conduct an oral briefing to NREL/DOE on the Implementation Plan within 30 days after subcontract award.

Task 4.3. Concept Development Effort. Following NREL/DOE approval of the Implementation Plan, the subcontractor shall lead and conduct a development effort on enabling component and system technology to meet the requirements of the Phase I goals. The development effort will consist of three activities under this task:

a. Concept Refinement & Requirements Definition. The subcontractor shall develop and define application requirements sufficiently to assist in guiding and directing concept refinement and technology development. The component/system technology or device proposed will then be refined to address and satisfy pertinent and critical heavy-vehicle hybrid propulsion requirements as they apply. The subcontractor may initially have several heavy vehicle applications in mind, but should be prepared to down select to one application for continuation of Phase I (for down select activity see paragraph b below).

b. Preliminary Technology Design Review. This effort will include a Preliminary Technology Design Review (PTDR) at 18 months after subcontract award (ASA) at which time progress, technology assumptions, applications, and projected energy savings, reliability and durability assessments as reviewed by NREL. Any vehicle, applications, and drive cycle down selections will be made at this PTDR. NREL/DOE shall mutually agree upon all down selections to one application (i.e., vehicle, application conditions, drive cycle).

c. Technology Development & Feasibility/Benefits Evaluation. Subcontractor shall perform the necessary component or system technology design activities, computer modeling and simulation work, computer model correlation and validation work, technology testing and demonstration, and test data analysis required to evaluate and judge the scientific and engineering feasibility of the proposed technology. Subcontractor shall evaluate the energy-savings, fuel-economy enhancing, and/or emissions-reducing benefits of the proposed technology. NREL/DOE encourage technology hardware projects that demonstrate some aspect or element of technology feasibility in Phase I. Subcontractor shall identify test facilities, develop test plans, and provide for labor and testing costs for any proposed Phase I projects involving hardware demonstrations. When possible, subcontractor shall correlate experimental results with computer modeling and simulation predictions, and incorporate correlation results into heavy vehicle hybrid models to advance the state-of-the-art in heavy vehicle hybrid component and system simulation.

d. Commercialization Assessment & Commercialization Plan Development. Subcontractor shall assess the heavy-vehicle hybrid propulsion commercialization potential, market penetration potential, market penetration timelines, and economic costs in sufficient detail to develop a cohesive and reasonable technology commercialization plan. The subcontractor shall estimate potential manufacturing, tooling, and labor costs required to achieve the claimed heavy vehicle hybrid propulsion fuel economy and emissions benefits on a best efforts basis in establishing the economic costs in heavy-vehicle hybrid applications.

Task 4.4. Phase I Report & Briefing. At the completion of Phase I, the subcontractor shall prepare a report of Phase I results and provide an in-depth oral briefing to NREL/DOE on the design, performance, technical merits and marketplace potential of the technology. The briefing shall include a proposed Phase II implementation plan. On the basis of the review, NREL/DOE will decide whether to initiate Phase II. If it is determined to proceed to Phase II, a formal Request for Proposal (RFP) will be issued by NREL to the subcontractor(s) on the basis of performance under Phase I subcontract(s).

Phase I will be governed by Government Performance and Results Act (GPRA) requirements. Therefore the subcontractor shall in all tasks identify and report on measurable performance metrics that are related to the fuel/energy savings goals of this Statement of Work and 2007 federal emissions standards. Subcontractor shall evaluate and discuss progress on these performance metrics in Monthly Technical Progress Reports, Quarterly Progress Reviews, and in the Final Technical Report (see sections 7.2, 7.3, and 7.4).

Table 2 shows the schedule anticipated for program tasks discussed above.

Table 2 – Phase I Program Schedule

Task Number	Task Description	Schedule
4.1	**Implementation Plan Development**	**30 days**
4.2	**Implementation Plan Briefing**	**31 days**
4.3a	**Concept Refinement & Requirements Definition**	**5 months**
4.3b	**Preliminary Technology Design Review**	**18 Months**
4.3c	**Technology Development & Feasibility/Benefit Evaluation**	**29 months**
4.3d	**Commercialization Assessment & Plan Development**	**32 months**
4.4	**Phase I Reporting & Briefing**	**33 months**

Phase II (For Information Purposes Only) – Phase II will consist of technology optimization, demonstration, and preparation for potential commercialization. Demonstration projects shall include a technology test demonstration in a Class 3 to Class 8 truck mutually agreed upon by NREL/DOE and the subcontractor. Although at this stage detailed Phase II tasks can be uncertain, it is anticipated that the following tasks shall be accomplished:

Program Implementation Plan Development. The subcontractor shall provide a detailed Implementation Plan and Work Breakdown Structure for the execution of Phase II. Proposed goals and technical and management approaches shall be identified for achieving program objectives. The plan shall identify the proposed tasks and responsibilities of all team members. It is anticipated that the subcontractor will have established sufficient heavy-vehicle industry relationships and inputs, the necessary technology design requirements in

Phase I, and the necessary technology design solutions in Phase I to guide and prepare a comprehensive Phase II Implementation Plan.

Program Implementation Plan Briefing. The subcontractor shall conduct an oral briefing to NREL/DOE on the Implementation Plan within 30 days after initiation of Phase II.

Technology Validation. Following NREL/DOE approval of the Implementation Plan, the subcontractor shall continue development of mutually agreed upon research and development efforts to meet the requirements of the Phase II goals. The subcontractor shall demonstrate the technology developed in Phase I in a Class 3 to Class 8 truck demonstration. It is anticipated that the validation effort will consist of 3 activities under this task:

a. Technology Optimization. Subcontractor shall optimize the technology for the final intended application and the technology demonstration vehicle tests. This will include optimizing for component design requirements, vehicle integration requirements, specific vehicle drive cycles, and specific internal or external conditions unique to the intended vehicle or application.

b. Technology Demonstration. Subcontractor shall perform a technology demonstration to validate the technology for its intended application, with intent of demonstrating up to a 100% increase in heavy vehicle fuel economy. This technology demonstration can be in a Class 3 to Class 8 vehicle that is most appropriate for the technology/device/component and demonstrating the program objectives. NREL/DOE and the subcontractor will mutually agree upon the vehicle demonstration.

c. Preparation for Commercialization. Subcontractor shall, based on the Phase I commercialization plan and any updated knowledge gained in Phase II efforts, prepare the technology/device/component for commercialization in the heavy vehicle industry. Subcontractor shall update the Phase I commercialization plan with any new knowledge or information concerning potential markets, market penetration potentials, market penetration timelines, production costs, and any other pertinent market or commercialization information.

Subcontractors should keep in mind how their Phase I efforts will effectively lead to and smoothly transition into this task activity in a potential Phase II effort.

Phase II Report & Briefing. At the completion of Phase II, the subcontractor shall prepare a report of Phase II results and provide an in-depth oral briefing to DOE/NREL on the design, performance, test results, technical merits and marketplace potential of the technology.

Phase II will be governed by Government Performance and Results Act (GPRA) requirements. Therefore the subcontractor shall in all tasks identify and report on all tasks measurable performance metrics that are related to the fuel/energy savings goals of the statement of work and 2007 federal emissions standards.

5.0 REVIEW MEETINGS

A Project Kickoff and Phase I Implementation Plan meeting will be held within 30 days of subcontract award at the NREL in Golden, CO. The subcontractor shall provide a project implementation plan complete with a program schedule of activity and milestones. Quarterly Review Meetings will also be

held at NREL in Golden, CO to review program technical progress, project schedule and milestones, design challenges and issues, technical barriers to success, management issues (including personnel and resource planning and budgets), and any other pertinent program information requested by NREL/DOE. A Final Review Meeting will be held at NREL, Golden, CO and will present the final results of the project to NREL / DOE representatives. The subcontractor is responsible for coordinating all these review meetings with NREL.

6.0 DELIVERABLES

Subcontractor shall allow NREL/DOE to participate, whenever feasible without interfering in the research and development progress, in any verification and testing of demonstration devices or prototype systems. Subcontractor shall provide to NREL/DOE a copy of the Program Implementation Plan as described in Section 4.0, Phase I Task 4.1 for Phase I work. Subcontractor shall support a Preliminary Technology Design Review as described in Section 4.0, Phase I Task 4.3b and prepare a PTDR briefing presentation given to NREL/DOE. Subcontractor shall provide Monthly Technical Progress Reports to NREL/DOE as described in Section 7.2 and shall provide Quarterly Progress Meeting data and presentations as described in Section 7.3. Subcontractor shall provide a Final Technical Report and Briefing for the Phase I work as described in Section 4.0, Phase I Task 4.4 and Section 7.4. Subcontractor shall provide an initial cost plan detailing the Work Breakdown Structure's (WBS) planned monthly expenditures for the subcontract as described in Section 7.5.

7.0 REPORTING REQUIREMENTS

The Subcontractor shall prepare and submit the following reports during the subcontract's period of performance. If the subcontract's period of performance begins during the first through the fifteenth of a month, then that month is considered the first full month of the subcontract for reporting purposes. If the period of performance for the subcontract begins during the sixteenth through the end of the month, then the first full month of the subcontract for reporting purposes is the following month. For example, if the period of performance start date is January 10, then January is the first full month for reporting purposes. If the period of performance start date is January 20, then February is the first full month for reporting purposes.

7.1 **Program Implementation Plan**: The Subcontractor shall provide to NREL within thirty (30) days after award of the subcontract and within fifteen (15) days after any agreed upon changes by both parties, a detailed program plan that covers the specific work breakdown structure for the subcontract effort. The program plan shall be sent to the Technical Monitor and the Contract Associate.

7.2 **Monthly Technical Progress Report**: The Subcontractor shall prepare and submit to NREL by the fifteenth day of each month a technical progress report. This report shall communicate an assessment of subcontract status, explain variances and problems, report accomplishment of performance milestones and/or program deliverables, and discuss any other areas of concern or achievement. This report shall correlate with the Work Breakdown Structure (WBS) for the subcontract. The original and three (3) copies of the report shall be sent to the Technical Monitor and one (1) copy of the reports shall be sent to the Contract Associate.

7.3 **Quarterly Progress Review**: The Subcontractor shall support a quarterly progress review conducted by NREL. Subcontractor shall provide quarterly review data to

demonstrate progress from last review and beginning of the contract, review design options, review design challenges, issues, and barriers to successful project completion, present project cost-to-date data, and review milestone completion status. The quarterly progress review presentation package can serve as the monthly technical progress report for the month when the quarterly review is held.

7.4 **Final Technical Report**: The Subcontractor shall prepare and submit to NREL a final technical report, both in draft and final version, describing all significant work performed during the entire subcontract's period of performance. In the event incremental funding is discontinued, the subcontractor shall submit a Final Technical Report for all work performed up to the point covered by incremental funding. The draft version shall be due fifty (50) days prior to the completion date of the subcontract. NREL will have twenty-five (25) days to review the draft version and provide written comments to the Subcontractor. The Subcontractor shall make any corrections or revisions per NREL's written comments within twenty-five (25) days after receipt and submit the final version to NREL with a reproducible master of the summary by the contract end date. Five (5) copies of the draft version shall be sent to the Technical Monitor and one (1) copy of the draft version shall be sent to the Contract Associate. The reproducible master and ten (10) copies of the final version shall be sent to the Technical Monitor and one (1) copy of the final version shall be sent to the Contract Associate.

7.5 **Cost Plan**: An initial cost plan detailing the Work Breakdown Structure's (WBS) planned monthly expenditures for the subcontract shall be prepared by the Subcontractor and submitted within fifteen (15) days after the effective date of the subcontract for the entire subcontract's period of performance. All cost sharing participants shall be indicated. The Subcontractor may utilize *Form 619AB -- Cost Plan* (available from the Contract Associate) or a similar format that would provide the same type of information. The Subcontractor shall update this cost plan whenever there is (a) a significant change in the planned expenditures versus the actual expenditures incurred or (b) written modification to the subcontract that results in changes to the cost. The original of the cost plan (s) shall be submitted to the Contract Associate and one (1) copy to the Technical Program Manager.

The reports shall be sent to the following address:

National Renewable Energy Laboratory
Attn: *****
Contract Associate MS 1632
Contracts and Business Services Office
1617 Cole Boulevard
Golden, CO 80401

National Renewable Energy Laboratory
Attn: *****
Technical Program Manager
Heavy Vehicle Hybrid Program
1617 Cole Boulevard, M.S. 1633
Golden, CO 80401